Please type a plus sign (+) inside this box → [+]

PTO/SB/05 (1/98)
Approved for use through 09/30/2000. OMB 0651-0032
Patent and Trademark Office: U.S DEPARTMENT OF COMMERCE

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. 0756-1880

First Inventor or Application Identifier Takashi INUSHIMA et al.

Title: CVD APPARATUS

Express Mail Label No.

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [X] Fee Transmittal Form (e.g., PTO/SB/17)
   (Submit an original, and a duplicate for fee processing)
2. [X] Specification *Total Pages* [12]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) (35 USC 113) *Total Sheets* [4]
4. [X] Oath or Declaration *Total Pages* [3]
   a. [ ] Newly executed (original or copy)
   b. [X] Copy from a prior application (37 CFR 1.63(d))
   (for continuation/divisional with Box 17 completed)
   [Note Box 5 below]
   i [ ] DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. [X] Incorporation By Reference *(useable if Box 4b is checked)*
   The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission
   (if applicable, all necessary)
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [ ] Assignment Papers (cover sheet & document(s))
9. [ ] 37 CFR 3.73(b) Statement [ ] Power of Attorney
   (when there is an assignee)
10. [ ] English Translation Document *(if applicable)*
11. [X] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [X] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503)
    (Should be specifically itemized)
14. [ ] *Small Entity Statement(s) (PTO/SB/09-12) [ ] Statement filed in prior application, Status still proper and desired
15. [ ] Certified Copy of Priority Document(s)
    (if foreign priority is claimed)
16. [ ] Other:

*A new statement is required to be entitled to pay small entity fees, except where one has been filed in a prior application and is being relied upon.

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17. **If a CONTINUING APPLICATION**, *check appropriate box, and supply the requisite information below and in a preliminary amendment*
[ ] Continuation **[XX] Divisional** [ ] Continuation-in-part (CIP) of prior application No. 08/769,115, filed Dec. 18, 1996
Prior application information: Examiner: B. Pianalto Group/Art Unit: 1762

18. CORRESPONDENCE ADDRESS

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Name *(Print/Type)* Jeffrey L. Costellia Registration No. *(Attorney/Agent)* 35,483

Signature [signature] Date: 11/10/98

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FEE TRANSMITTAL

Patent fees are subject to annual revision on October 1. These are the fees effective October 1, 1997. Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid. See Forms PTO/SB/09-12.

TOTAL AMOUNT OF PAYMENT ($) 790 00

Complete If Known	
Application Number	New Application
Filing Date	November 10, 1998
First Named Inventor	Takashi INUSHIMA et al
Examiner Name	B. Pianalto
Group Art Unit	1762
Attorney Docket Number	0756-1880

METHOD OF PAYMENT (check one)

1. [ ] The Commissioner is hereby authorized to charge indicated fees and credit any over payments to
Deposit Account No 19-2380
Deposit Account Name SIXBEY, FRIEDMAN, LEEDOM & FERGUSON, PC

[X] Charge Any Additional Fee Required Under 37 CFR 1 16 and 1 17
[ ] Charge the Issue Fee Set in 37 CFR 1 18 at the Mailing of the Notice of Allowance

2 [X] Payment Enclosed
[X] Check [ ] Money Order [ ] Other

FEE CALCULATION

1 BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	790	201	395	Utility filing fee	[790 00]
106	330	206	165	Design filing fee	[ ]
107	540	207	270	Plant filing fee	[ ]
108	790	208	395	Reissue filing fee	[ ]
114	150	214	75	Provisional filing fee	[ ]
				SUBTOTAL (1)	[790 00]

2 EXTRA CLAIM FEES

	Extra Claims		Fee from Below		Fee Paid
Total Claims	13 - 20** =	0	X 22	=	$ 0
Independent Claims	3 - 3***=	0	X 82	=	$ 0
Multiple Dependent Claims			-0-	=	$ 0

**or number previously paid, if greater, For Reissues, see below

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	22	203	11	Claims in excess of 20
102	82	202	41	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim
109	82	209	41	**Reissue independent claims over original patent
110	22	210	11	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) [-0-]

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge-late filing fee or oath	
127	50	227	25	Surcharge-late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Ext for reply within first month	
116	400	216	200	Ext for reply within second mth	
117	950	217	475	Ext for reply within third mth	
118	1,510	218	755	Ext for reply within fourth mth	
128	2,060	228	1,030	Ext for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing brief in support of appeal	
121	270	221	135	Request for Oral Hearing	
138	1,510	138	1,510	Petition to institute public use proceeding	
140	110	240	55	Petition to revive-unavoidable	
141	1,320	241	660	Petition to revive-unintentional	
142	1,320	242	660	Utility issue fee (or reissue)	
143	450	243	225	Design issue fee	
144	670	244	335	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of IDS	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	790	246	395	Filing a submission after final rejection (37 CFR 1 129(a))	
149	790	249	395	For each additional invention to be examined (37 CFR 1 129(b))	
				Other	
				Other	
				*Reduced by Basic Filing Fee Paid	
				SUBTOTAL (3)	$ -0-

SUBMITTED BY

Complete (if applicable)

Typed or Printed Name	Jeffrey L. Costellia			Reg. Number	35,483
Signature	J. L. Costellia	Date	11/10/98	Deposit Account User ID	

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Divisional application of	)
Takashi INUSHIMA et al.	)
Based on Serial No. 08/769,115	) Art Unit: 1762
Filed: November 22, 1998	) Examiner: B. Pianalto
For: CVD APPARATUS	) Date: November 10, 1998

PRELIMINARY AMENDMENT

Honorable Assistant Commissioner for Patents

Washington, D.C. 20231

Sir:

Please preliminarily amend the subject application as follows.

IN THE SPECIFICATION:

Before the first sentence of the specification, insert:

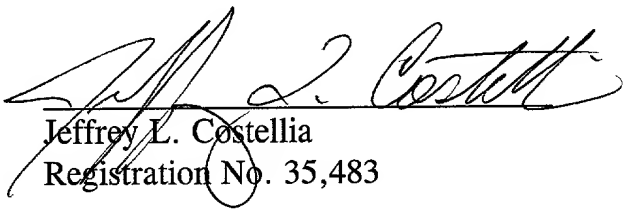
--This application is a Divisional of Application Serial No. 08/769,115, filed December 18, 1996, which is itself a Divisional of Application Serial No. 08/376,736, filed January 23, 1995, now U.S. Patent No. 5,629,245, which is itself a Divisional of Application Serial No. 07/971,242, filed September 8, 1992, now U.S. Patent No. 5,427,824.--

REMARKS

This application has been amended to include the continuing application data thereof.

Examination on the merits is requested.

Respectfully submitted,



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Registration No. 35,483

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CVD APPARATUS

Related Applications

This Application is a COntinuation-in-Part of copending Application Serial No. 07/497,794; which in turn is a Continuation of Application Serial No. 07/091,770, now abandoned.

Background of the Invention

The invention relates to a photo enhanced CVD apparatus.

Many chemical vapor deposition (CVD) processes are used, such as APCVD, LP CVD, plasma CVD, thermal CVD and so forth, for depositing a film on a substrate. WHile these processes have their own peculiar characteristics respectively, the temperature at which each process is carried out is commonly rather high. Such high temperature process is not suitable for formation of passivation film on an aluminum electrode arrangement.

Photo enhanced CVD process has attracted the interest of artisans because it can be carried out at a comparatively low temperature. This process is based on the energy of light, namely an optical reaction is carried out. For example, in the case of photo CVD process using silane and ammonia, mercury atoms are excited by irradiation of ultraviolet light of 2,537Å in wavelength. The process is carried out to deposit a silicon nitride film on a substrate in accordance with the following equation:

$Hg + hv \rightarrow Hg^*$ ("*" is a symbol for excitation)

$Hg^* + SiH_4 \rightarrow SiH_3 + H- + Hg$ ("-" is a symbol for radical)

$Hg^* + NH_3 \rightarrow NH_2- + H- + Hg$

$yNH_2- + xSiH_3 \rightarrow Si_xN_y + zH_2$

In the above equations, x, y and z are chosen appropriately.

Fig. 1 is a cross-section view showing a photo CVD apparatus which has been devised by the inventors in advance of the present invention. To facilitate the understanding of the background of the present invention, this apparatus will be briefly explained. In the figure, the apparatus comprises a reaction chamber 31, light source chambers 39 and ultraviolet light sources 41. Between the light source chambers 39, a cart 35 is mounted so as to be capable of moving in the direction perpendicular to the drawing sheet. The cart is provided with heaters 37 to heat substrates mounted on the external surfaces of the cart 35 facing to the light source chambers 39. The temperature of the substrates 33 is elevated to about 200°C which is suitable for forming a silicon nitride film. In the reaction chamber 31 is circulated a process gas at a pressure of several Torrs. The process gas is irradiated through quartz windows 47 with light radiated from the light source 41. A numeral 45 designates electrodes by virtue of which discharge takes place with the cart as the other electrode and undesired product deposited on the surface of the quartz windows 47 can be eliminated by sputtering.

However, with this apparatus, the thickness of deposited film depends on th spatial relationship between the light sources and the position of the substrates. Namely, the product of the CVD process may

be deposited with a greater thickness at the position irradiated with stronger light. Generally speaking, the tolerable fluctuation of the thickness of the film is about 10%. Furthermore, the quartz windows 47 have to be thick to bear the differential pressure between the inside of the reaction chamber 31 and the light source chamber 39 in which cooling gas is circulated. The differential pressure may cause leakage of the cooling gas from the light source chamber 39 into the reaction chamber 31. As an alternative, a particular cooling system may be provided for the light source chamber so the pressure in the light source chamber, and therefore the differential pressure, can be decreased. Also, when discharge between the cart 35 and the reaction chamber 31 is desired to remove unnecessary film deposited on the light window by sputtering, the discharge tends to deviate from the window. Because of this, the particular electrodes 45 have to be provided which makes the size of the apparatus large.

As to unevenness of film deposited by CVD, it is also the problem in the case of plasma CVD. The energy of plasma seems dependent on the relationship between the substrate and a pair of electrodes for discharge. So a uniform deposition condition on a substrate to be coated is also demanded for plasma CVD.

Summary of the Invention

It is therefore an object of the invention to provide an CVD apparatus with which a film can be deposited with a uniform thickness.

It is another object of the invention to provide a CVD apparatus with which a film can be deposited with high quality.

It is a further object of the invention to provide a cheaper CVD apparatus.

It is still a further object of the invention to provide a compact CVD apparatus.

Brief Description of the Drawings

Fig. 1 is a cross-section view of an example of a photo CVD apparatus.

Fig. 2 is a cross-section view showing an embodiment of the invention.

Fig. 3 is a cross-section view taken along a III-III line of Fig. 2.

Fig. 4 is a cross-section view showing another embodiment of the invention.

Figs. 5(A) to 5(C) are graphical diagrams showing the distributions of the intensity on substrates mounted on prism-shaped substrate holder having cross-sections of regular polygons of 6, 12, and 24 sides.

Figs. 6(A) to 6(C) and Fig. 7 are section views showing the process of an example of CVD in accordance with this invention.

Detailed Description of the Preferred Embodiment

Referring to Fig. 2 and Fig. 3, a photo enhanced CVD apparatus in accordance with the invention is illustrated. In the figure, the apparatus 1 comprises a reaction chamber 3, a hexagonal cart as a substrate holder having six lateral faces on which substrates 15 are mounted, a driving device 9 with a motor 21 for rotating the cart 7 around its axis, a plurality of quartz tubes 17, which may be alternatingly provided of different diameters, on the inside of the reaction chamber 3, with one end of each tube at a constant

angular distance around the cart 7 and with the other end of each tube being closed, mercury lamps 19 provided in and housed air-tightly by the quartz tube respectively, halogen lamp heaters 23 arranged along the axial direction, a process gas introduction system 11, and an exhaustion system 13. A cooling gas, such as nitrogen gas, is circulated in the quartz tubes 17 by means of recirculation means 29. On each face of the cart 7, two substrates each 35 cm long and 30 cm wide can be mounted, and therefore the cart 7 can hold twelve substrates thereon. The cart is preferentially removable from the driving device so that substrates can be mounted outside the reaction chamber 3.

Next, the process in the apparatus will be explained. First, twelve substrates are mounted on the cart 7 and entered into the reaction chamber 3. After evacuating the reaction chamber 3 to 10^{-2} - 10^{-6} Torr by means of the exhaustion system 13, a process gas is inputted from the introduction system 11 at about 3 Torr. Simultaneously, the substrates 15 are heated by the heater 23 to about 200°C. Then, the cart 7 encircled by the mercury lamps 19 is rotated at 2 rpm by the driving device 9 and irradiated with ultraviolet light from the lamps 19, whereupon the product of a reaction initiated by optical energy is deposited on the substrates 15. The product undesirably deposited on the quartz tubes 17 can be removed by sputtering in virtue of discharge between the cart 7 and the reaction chamber 3. Photo enhanced CVD process is carried out, e.g., in accordance with the following equation:

$$3Si_2H_6 + 8NH_3 \rightarrow 2Si_3N_4 + 21H_2 \text{ or}$$
$$SiH_4 + 4N_2O \rightarrow SiO_2 + 4N_2 + 2H_2O \quad (1)$$

Referring now to Fig. 4, another embodiment of the invention is illustrated. This embodiment is same as the preceding embodiment except for the number of side faces of a cart and provision of an electrode 49 in the form of a cylindrical wire net disposed between the cart 7 and the reaction chamber 3. The cart has twelve side faces each capable of holding two substrates. The electrode 49 is used both for generating plasma gas by discharging between itself and the cart 7, and for carrying our etching eliminating unnecessary product deposited on the inside wall of the reaction chamber 3, the external surfaces of the light sources 5 and so forth. The electrode 49 can be placed between the light sources 5 and the cart 7 instead. Plasma CVD may be implemented simultaneously by causing discharge during photo CVD process, or may be implemented after deposition by photo CVD. Plasma CVD is carried out, e.g., using TEOS (tetra-ethyl-oxy-silane) in accordance with the following equations:

$$SiO_4(C_2H_5)_4 + 14O_2 \rightarrow SiO_2 + 8CO_2 + 10H_2O, \text{ or}$$
$$SiO_4(C_2H_5)_4 + 28N_2O \rightarrow SiO_2 + 8CO_2 + 10H_2O + 28N_2 \quad (2)$$

After taking out, from the reaction chamber, the substrates on which the deposition has been deposited, undesirable deposited product is removed from the inside of the reaction chamber by means of etching in virtue of discharge between the cart 7 and the electrode 49. The etching is carried out, e.g., in accordance with the following equations:

$$Si_3N_4 + 4NF_3 \rightarrow 3SiF_4 + 4N_2$$
$$3SiO_2 + 4NF_3 \rightarrow 3SiF_4 + 2N_2 + 3O_3$$

To investigate the relationship between the uniformity of the illumination intensity on the substrate and the number of side faces of the cart, experimental data has been gathered. Figs. 5(A) to 5(C) are graphical diagrams showing the distributions of the intensity on substrates mounted on prism-shaped substrate holders having cross-sections of regular polygons of 6, 12 and 24 sides. In the figure, the abscissa is the distance of the measuring point from the center of a substrate, and the ordinate is the intensity normalized with reference to the maximum intensity measured on the substrate. As shown from the diagrams, the distribution of the intensity becomes more uniform as the number of the faces increases. Namely, the intensity fluctuates over the irradiated surface at larger than 10% in the case of the cart having six faces, while the fluctuation of the intensity is limited within 5% in the cases of the carts having twelve and twenty-four faces. The cart having twenty-four faces may hold forty-eight substrate by mounting two substrates on each face.

Figs. 6(A) to 6(C) are cross-section views showing an example of CVD process in accordance with the present invention. The surface of a substrate to be coated is provided with a plurality of aluminum lead lines 51. The leads 51 are elongated in the direction perpendicular to the drawing sheet with 0.8 micron in height, 0.6 micron in width and 0.9 micron in interval as shown in Fig. 6(A). A silicon oxide film is deposited on the substrate over the leads 51 by photo CVD in accordance with the equation (1) to the thickness of 0.3 to 0.5 at about 400°C as shown in Fig. 6(B). Further, another silicon oxide film 55 is deposited by plasma CVD in accordance with the equation (2) at 200°C as shown in Fig. 6(C).

The use of TEOS is advantageous particularly for forming a film on an uneven surface, specifically, it is possible to form a substantially even or uniform film, even on a side surface of or on a lower surface between the steps shown in Fig. 6(A) by reference numeral 51. It is presumed that this is because TEOS is in a liquid state at room temperature and has a relatively large viscosity even when it is gasified. The even upper surface is desirable when provided with an overlying aluminum electrode 57 as shown in Fig. 7. The likelihood of disconnection of electrode 57 is reduced by the even surface. After the completion of the deposition, the inside of the reaction chamber on the mercury lamp 19, only one being schematically shown in Figs. 6(A) to 6(C). The etching process can be implemented on the deposited film before or after plasma CVD in order to obtain even surface of the film or to chamfer the edge of the film deposited.

By use of this process, film is deposited with a constant thickness throughout the surface of the substrate 15 in the light of the uniform irradiation over each substrate. However, the uniformity of the thickness can be further improved by modulating the intensity of the mercury lamps 19 in synchronization with the rotation of the cart 7, or by modulating the angular speed of the cart 7 in correspondence with the relative position to the mercury lamps 19. According to the gist of the invention, it is easily understood that the performance of non-photo enhanced plasma CVD is also improved by the use of the rotatable substrate holder.

The invention should not limited to the above particular embodiments and modifications and variations are possible as would be recognized by those skilled in the art. As the cross-section of the cart 7, other

regular or irregular polygons, or circle can be employed. Also the driving device can be provided on the top side of the reaction chamber, or on the lateral side with pinion gear, in place of the bottom side as shown in Fig. 2.

What is Claimed is:

1. A method for forming a device comprising the steps of:

forming a first layer comprising a material selected from the group consisting of silicon oxide and silicon nitride on a surface by CVD using a first reactive gas containing a gas selected from the group consisting of SiH_4 and Si_2H_6;

forming a second layer comprising silicon oxide on said first layer by plasma CVD using a second reactive gas comprising at least organic silane.

2. A method according to claim 1 further comprising a step of etching a surface of said second layer.

3. A method according to claim 1 wherein said organic silane is TEOS.

4. A method according to claim 1 wherein the CVD for forming the first layer is a photo CVD.

5. A method for forming a device comprising the steps of;

forming a first layer comprising a material selected from the group consisting of silicon oxide and silicon nitride on a surface having a step by CVD using a first reactive gas containing a gas selected from the group consisting of SiH_4 and Si_2H_6; and

forming a second layer comprising silicon oxide on said first layer by plasma CVD using a second reactive gas comprising at least organic silane.

6. A method according to claim 5 further comprising a step of etching a surface of said second layer.

7. A method according to claim 5 wherein said organic silane is TEOS.

8. A method according to claim 5 wherein the CVD for forming the first layer is a photo CVD.

9. A method for forming a device comprising the steps of:

preparing a substrate having a plurality of conductive lines thereon;

forming a first layer comprising a material selected from the group consisting of silicon oxide and silicon nitride over said plurality of wirings by CVD using a first reactive gas containing at least one of SiH_4 and Si_2H_6; and

forming a second layer comprising silicon oxide on said first layer by plasma CVD using a second reactive gas containing at least organic silane; and

forming an electrode on said second layer.

10. A method according to claim 9 further comprising a step of etching a surface of said second layer.

11. A method according to claim 9 wherein said organic silane is TEOS.

12. A method according to claim 9 wherein the CVD for forming the first layer is a photo CVD.

13. A method according to claim 9 wherein said second reactive gas further contains nitrogen oxide.

ABSTRACT

An improved CVD apparatus for depositing a uniform film is shown. The apparatus comprises a reaction chamber, a substrate holder and a plurality of light sources for photo CVD or a pair of electrodes for plasma CVD. The substrate holder is a cylindrical cart which is encircled by the light sources, and which is rotated around its axis by a driving device. With this configuration, the substrates mounted on the cart and the surroundings can be energized by light of plasma evenly throughout the surfaces to be coated.

FIG. 1

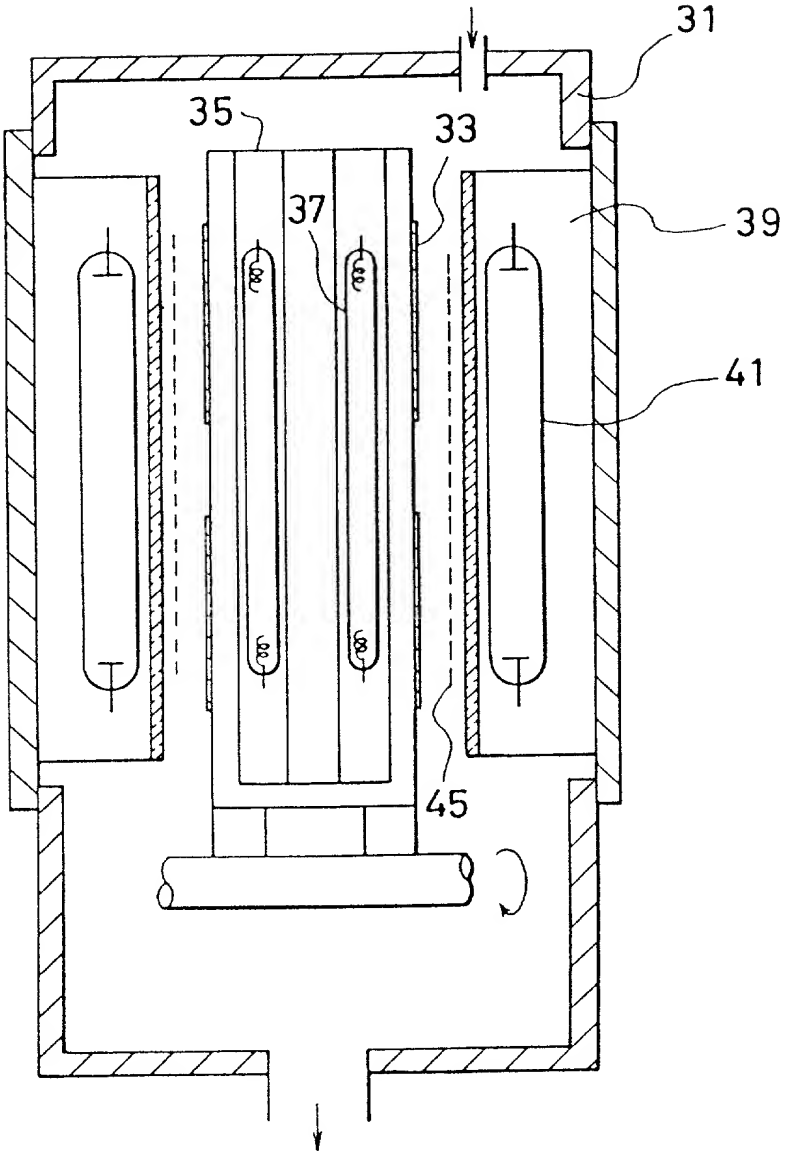


FIG. 2

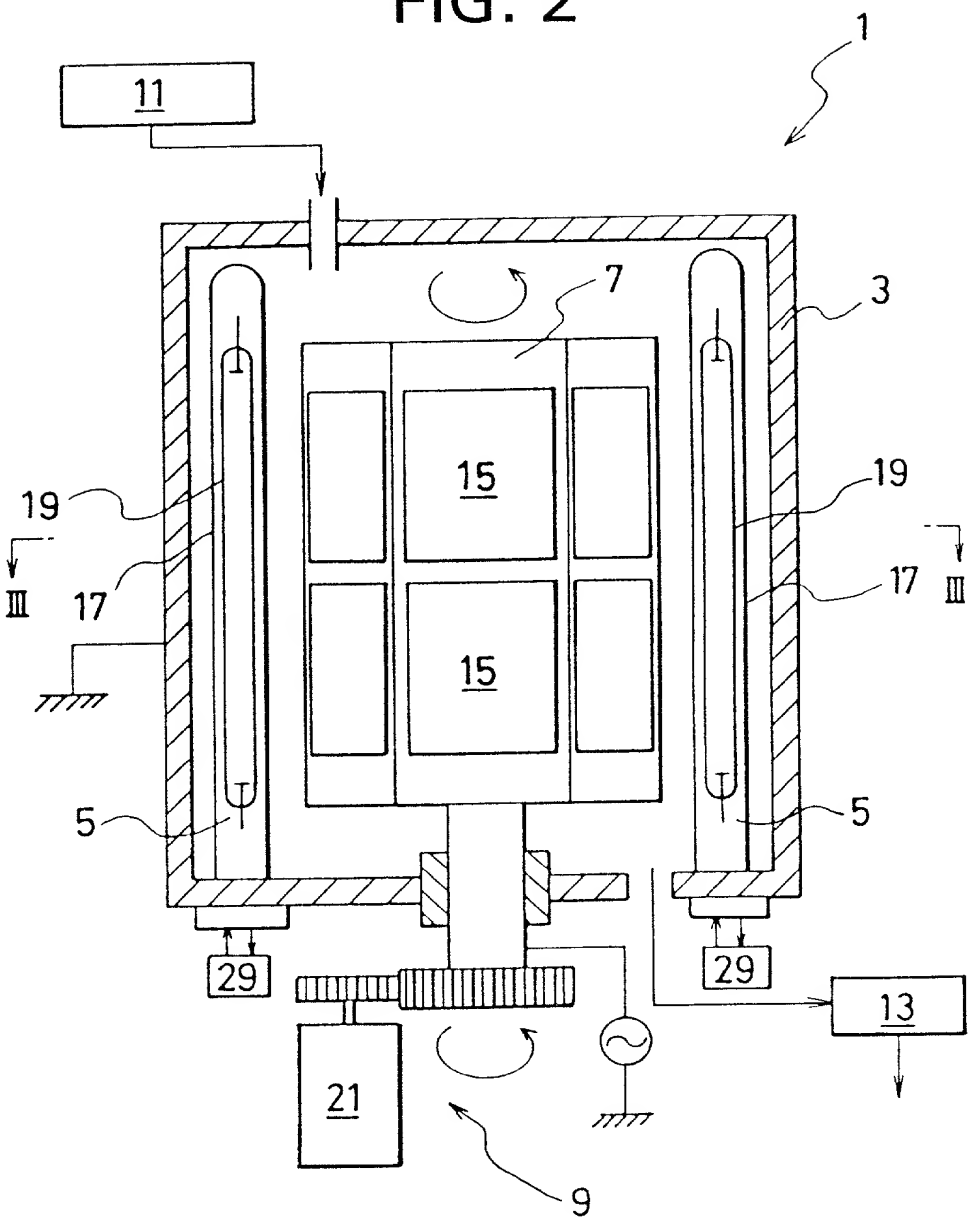


FIG. 3

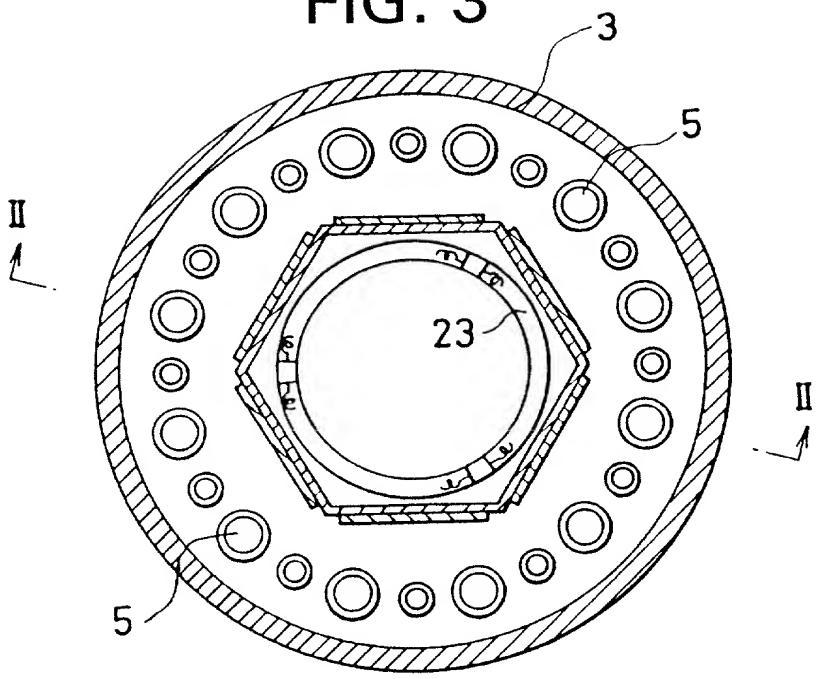


FIG. 4

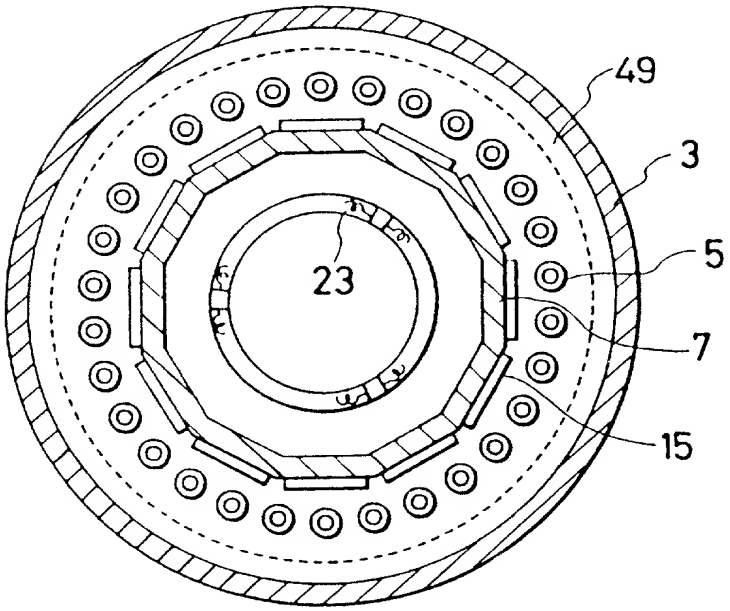
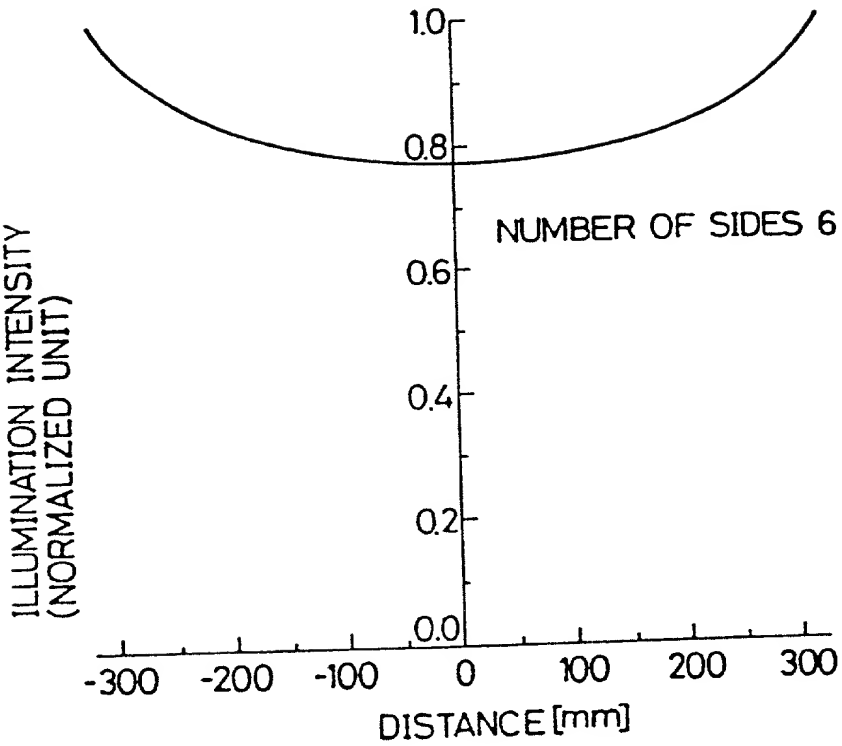


FIG.5A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0.6
0.4
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0.0
NUMBER OF SIDES 6
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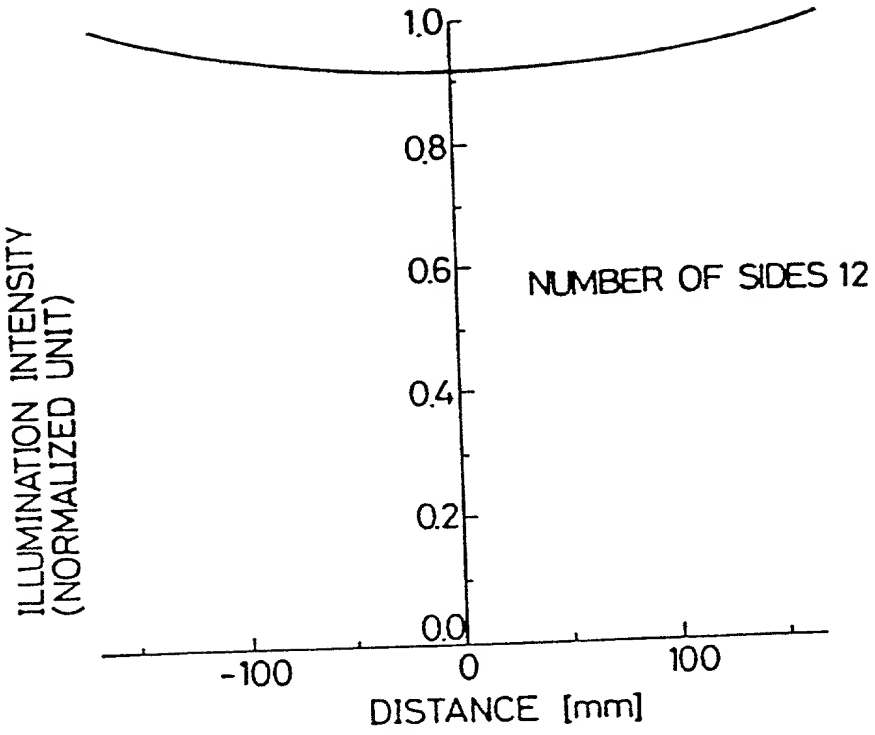
(NORMALIZED UNIT)
-300
-200
-100
0
100
200
300
DISTANCE [mm]

FIG.5B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(NORMALIZED UNIT)
NUMBER OF SIDES 12
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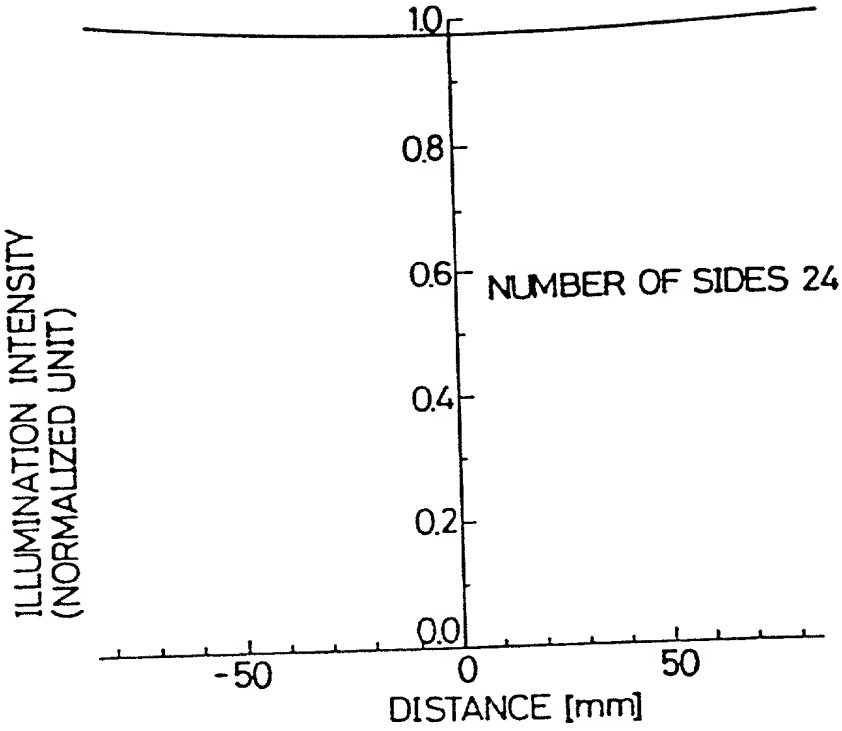
100
DISTANCE [mm]

FIG.5C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0.6
0.4
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(NORMALIZED UNIT)
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0
50
DISTANCE [mm]

FIG.6A

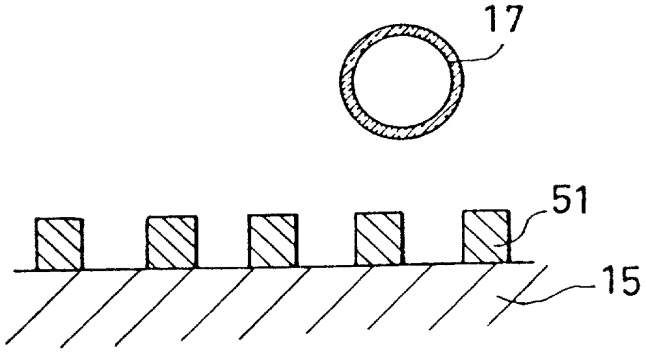


FIG.6B

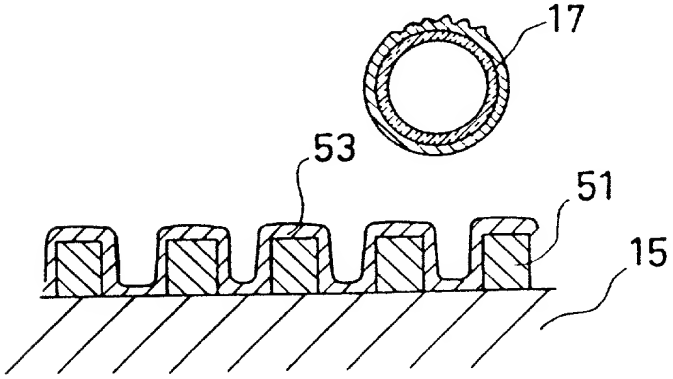


FIG.6C

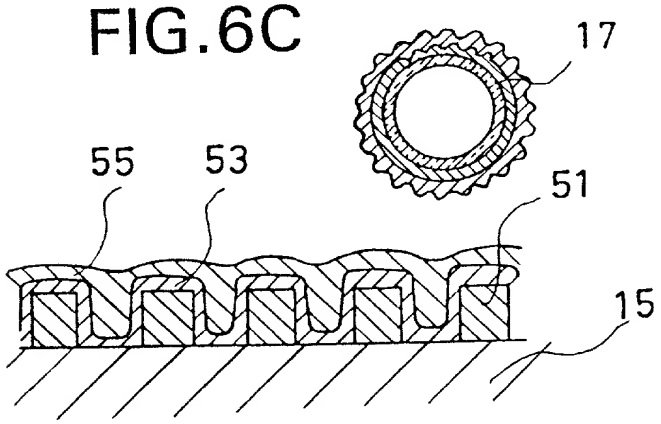
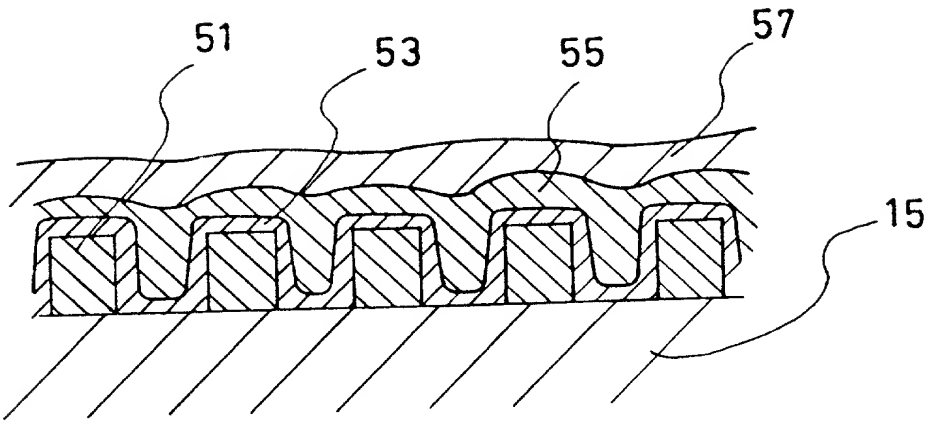


FIG. 7



DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

ATTORNEY DOCKET NO.

91-P205-USA-G

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention entitled: * CVD Apparatus

Insert Title

______________________________________, the specification of which is attached hereto unless the following box is checked:

Check Box If Appropriate — For Use Without Specification Attached

☐ The specification was filed on ______________
and was assigned Serial No. ______________ (if known)
and was amended on ______________ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof, or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows:

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and checked at right:

Prior Foreign Application(s)

Insert Priority Information (if appropriate)

(Number)	(Country)	(Month/Day/Year Filed)	Priority Claimed Yes	Priority Claimed No
61-213323	JAPAN	09/09/1986	☒	☐
61-213324	JAPAN	09/09/1986	☒	☐
61-213325	JAPAN	09/09/1986	☒	☐
62-141050	JAPAN	05/06/1987	☒	☐
			☐	☐

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More Than 12 Months Prior To The Filing Date of This Application:

Country	Application No.	Date of Filing (Month/Day/Year)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	(Filing Date)	(Status—patented, pending, abandoned)
07/091,770	09/01/1987	Abandoned
07/497,794	03/22/1990	Pending

Revised 11/90

*NOTE: Must be completed.

I hereby appoint the following attorneys to prosecute this application and/or an international application and to transact all business in the Patent and Trademark Office connected therewith:

Daniel W. Sixbey (Reg. No. 20,932)	Gerald J. Ferguson, Jr. (Reg. No. 23,016)
Stuart J. Friedman (Reg. No. 24,312)	David S. Safran (Reg. No. 27,997)
Charles M. Leedom, Jr. (Reg. No. 26,477)	Thomas W. Cole (Reg. No. 28,290)

Send Correspondence to:

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING ⬇

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Insert Name of Non-U.S. firm, attorney or agent ➡

The undersigned hereby authorize any U. S. attorney or agent named herein to accept and follow instructions from _____ as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U. S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys or agents named herein will be so notified by the undersigned.

Insert Full Name of First or Sole Inventor and Date This Document Is Signed ➡	FULL NAME OF SOLE OR FIRST INVENTOR Takashi Inushima	INVENTOR'S SIGNATURE Takashi Inushima	DATE 1991 5/13
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Third Inventor: see above	FULL NAME OF THIRD JOINT INVENTOR, IF ANY Toru Takayama	INVENTOR'S SIGNATURE Toru Takayama	DATE 1991 5/13
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Fourth Inventor: see above	FULL NAME OF FOURTH JOINT INVENTOR, IF ANY Masakazu Odaka	INVENTOR'S SIGNATURE Masakazu Odaka	DATE 1991 5/13
	RESIDENCE (City, State & Country) Akita 018-01, Japan	CITIZENSHIP Japanese	
	POST OFFICE ADDRESS (Complete Street Address including City, State & Country) TDK Matsukazeryo, A410, 58, Kanmurishishita, Kisakata-cho, Yuri-gun, Akita, 018-01, Japan		

Full Name of Fifth Inventor, if any: see above

GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE
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CITIZENSHIP: Japanese

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Full Name of Seventh Inventor, if any: see above

GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE

RESIDENCE (City, State & Country):

CITIZENSHIP:

POST OFFICE ADDRESS (Complete Street Address including City, State & Country):

Full Name of Eighth Inventor, if any: see above

GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE

RESIDENCE (City, State & Country):

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Full Name of Ninth Inventor, if any: see above

GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE

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Full Name of Tenth Inventor, if any: see above

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GIVEN NAME	FAMILY NAME	INVENTOR'S SIGNATURE	DATE

RESIDENCE (City, State & Country):

CITIZENSHIP:

POST OFFICE ADDRESS (Complete Street Address including City, State & Country):

* Note: Use this sheet for applications having more than four inventors